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Nasogastric tube placement verification with ultrasound by emergency nurses

Nasogastric tube placement verification with ultrasound applied by nurses

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Abstract
Aim: Nasogastric tube placement is a common procedure. Its insertion can lead to pulmonary complications, perforation, and even death. It is imperative to confirm the placement of the nasogastric tube. Ultrasound is a diagnostic method which can be used to confirm nasogastric tube placement. It has been used successfully not only by physicians but by nurses as well. We aimed to determine the skills of emergency nurses to use the ultrasound for the confirmation of nasogastric tube placement after ultrasound training.
Material and Methods: This study is a single-center, prospective and single-blind study. The study was performed to evaluate the ability of emergency nurses to confirm correct nasogastric tube placement. Six emergency nurses were given theoretical education and hands-on training about ultrasound. They confirmed the location of the nasogastric tube using ultrasound.
Results: A total of 84 patients were included in the study. According to the radiograph, the tube was not in the stomach in two out of 84 patients. While ultrasound verified that the tube was not in the stomach for 5 patients, it detected these two patients. The sensitivity and specificity of ultrasound performed by nurses were 96.34% and 100%, respectively. The area under the curve calculated for the predictive power of the nurses' ultrasound findings according to the radiography results was found to be 0.982 and statistically significant (p<,0.0001).
Discussion: Ultrasound can be performed by nurses the confirmation of correct nasogastric tube placement. Additionally, ultrasound may not be able to eliminate but significantly reduce the need for radiography.

Keywords
Nasogastric Tube, Enteral Nutrition, Emergency Nurse, Emergency Department, Point-of-care Ultrasound

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Introduction

Nasogastric tube (NGT) placement is a common procedure for diagnosis and treatment in the emergency department (ED) and intensive care unit (ICU). It is most commonly used for gastric decompression, drug administration and enteral nutrition [1,2]. Enteral nutrition is a vital component in the care of critically ill patients [2]. Both NGT placement and enteral feeding are routine practices, generally performed by nurses. In the USA, approximately 1,2 million NGTs are inserted annually for enteral nutrition in adult and pediatric patients [3]. Although NGT insertion is generally seen as a simple uncomplicated procedure, it actually requires skill and expertise [4]. NGT insertion can lead to pulmonary complications (pneumothorax, pneumomediastinum, pneumonia, pulmonary hemorrhage, empyema, hemothorax, bronchopleural fistula), perforation, and even death [5]. Due to these reasons, it is imperative to confirm the placement of the NGT. In critically ill patients who are uncooperative, have anatomical abnormalities and lack a swallowing reflex, the procedure is difficult and hence the risk of complications increases [6]. The misplacement rate of NGT has been reported between 0.3% and 8%, but the exact frequency is tough to estimate [7].

The recommended methods to confirm NGT position are auscultation, pH measurement, capnography, and radiography [8]. It has been reported that pH measurement does not always give accurate results due to proton pump inhibitors or H2 receptor antagonists being used in the treatment of critical patients commonly [9,10]. It has been shown that the auscultation method, frequently used by nurses, is not safe enough in patients with lung localization [11]. Capnography, on the other hand, may give false results because the NGT is inserted in the mouth or throat. It has also been reported that the capnogram alone does not fully reflect the tube position [12,13]. With these tests having limitations in confirming NGT, radiography remains the gold standard diagnostic method, but it carries a high cost and radiation [8].

In EDs and ICUs, Ultrasound (US) is a diagnostic method, which can be used to confirm NGT placement as it can be applied at bedside, is easier, faster, inexpensive, and does not expose patient to radiation [14]. In recent years, US has been used successfully not only by physicians but by nurses as well. Based on the available evidence, it is shown that nurses have performed peripheral vascular access under US guidance, detected B lines and pleural effusion in heart failure, volume evaluation in hemodialysis patients [15-17]. To the best of our knowledge, there is no study in which emergency nurses have performed US-guided NGT placement. In this study, we aimed to determine the skills of emergency nurses in using US for the confirmation of NGT placement following US training and later compare the same with radiography.

Material and Methods

Study Settlement

This study is a single-center, prospective and single-blind study. The study was carried out in the 2nd level ICU. In our hospital, 2nd level intensive care unit is managed by emergency physicians. The study was approved by Bozyaka Training and Research Hospital ethics committee and was conducted in accordance with the Declaration of Helsinki. Patients who were admitted to the ICU between August 2021 and October 2021 and were 18 years or older with an indication for enteral nutrition were included in the study. Indication for enteral nutrition was determined by the specialist in charge of the ICU. Informed consent was obtained from the patients /relatives. The study was approved by the ethical review board (University of Medical Sciences Izmir Bozyaka Training and Research Hospital - non-interventional clinical trials ethics committee, number: 2021/170 and date:13/10/2021).

Exclusion Criteria

Patients under the age of 18, pregnant, those having undergone neck surgery/gastric bypass surgery, with any anatomical deformity, with a history of midface injury and/or skull base fracture, esophageal stenosis or alkaline injury, severe coagulopathy, and/or having an open wound in the area where US had to be applied, and those who did not consent were excluded from the study.

Study Model

This study was planned in two stages. In the first stage, a training program was conducted to train all emergency nurses. Nurses participating in the study had no previous formal training in confirming NGT placement under US guidance. Within the scope of this training program, 6 nurses with at least 5 years of professional experience were given theoretical information about US-confirmation for NGT application, and training videos for the same were played for 30 minutes. Following this schedule, hands-on training was imparted by an emergency physician carrying more than 20 years of experience in Point-of-Care US. European-accredited ultrasonography courses were organized so as to get used to both the use of US and stomach anatomy in patients who had undergone NGT placement. After the training program, emergency nurses were instructed to perform ten successful NGT placement verifications with US under the supervision of the same physician.

Participants

Six emergency nurses working in Bozyaka Training and Research Hospital's 2nd level ICU, with at least 5 years of experience and voluntarily willing to participate in the study, took part in this study.

Outcome criteria

NGT length was determined by measuring the distance from the patient's nose tip to the earlobe tip and then to the xiphoid process and then adding 10 cm to this measurement. The procedure was performed on the patients by selecting the appropriate nostril, lubricating the tip of the tube with 0.9% saline solution, marking the location of the measured tube with hypoallergenic tape, inserting the tube from the selected nostril to the mark, and fixing the tube to the nose. NGT was placed blindly by nurses responsible for the patient's care. The same type and brand of NGT (Levin® polyurethane, radiopaque) was used in the patients. Tube size used was that of 16 French. After the NGT was placed, the nurse in charge of the study was informed. Mindray® M5 (Mindray Medical Corporation, Shenzhen, China) US machine equipped with a 5 MHz curved array probe was used for US probe placed on the subxiphoid

region and then directed towards the left upper abdominal quadrant to visualize the stomach area. To confirm the location of the NGT, 20 cc of air was injected with a 50 cc pine-tipped syringe, and an image of the dynamic hyperechogenic air shadow in the stomach was seen by US. Finally, chest X-ray was taken for all patients. These radiographs were interpreted blindly by two emergency medicine specialists with at least ten years of emergency department experience. Radiography was considered the gold standard for verification of NGT placement.

Collecting the Data

Demographic data of the patients (age, gender, body mass index), vital signs, if they were intubated/not, confirmation of the location of the tube by US and radiography, and related complications were recorded.

Statistical Method

A normality analysis of continuous measures was performed by the Kolmogorov–Smirnov analysis, Shapiro–Wilk test, and Q-Q plots. In statistical analysis, evaluation of inter-observer agreement, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy and AUC area calculations were made with SPSS 26th version. In all statistical evaluations, $p<0.05$ was accepted as the statistical significance limit value, and a 95% confidence interval was used for the mean values of all parameters.

Results

A total of 84 patients (52 malee, 32 females) with a mean age of 69.77±14.31 years were included in the study. Clinical and demographic characteristics of the patients are summarized in Table 1.

According to the radiograph, the tube was not in the stomach in two out of 84 patients. While US verified that the tube was not in stomach for 5 patients, it detected these two patients. In these patients, the tube was folded in the pharynx. The sensitivity and specificity of US performed by nurses were 96.3% and 100%, respectively, PPV was 100% and NPV was 40% (Table 2). In the Kappa agreement analysis for the compatibility of the US results for nurses and radiography results, US findings and radiography results of all nurses were mostly consistent (kappa=0.556)(p=0.000) (Table 3).

The area under the curve (AUC) value calculated in the Receiver Operating Characteristic (ROC) analysis performed for the

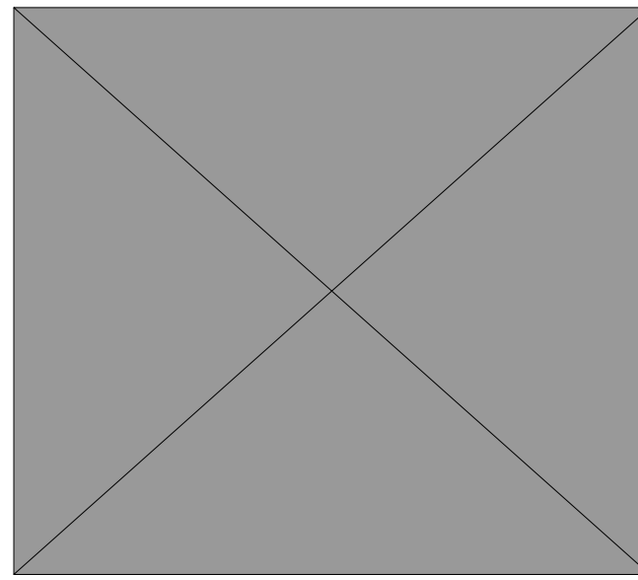

Figure 1. ROC curve performed for the predictive power of the nurses' US findings compared to radiography results

Table 1. Clinical and demographic characteristics of the patients

		n	%
GCS	<8	33	39,3
	>8	51	60,7
Gender	Female	32	38,1
	Male	52	61,9
Intubated	Yes	54	64,3
	No	30	35,7
Complication		0	0
		Mean.±SD	**Median (Min.-Max.)**
Age (years)		69,77±14,31	72,5 (26-94)
Systolic BP (mmHg)		130,68±29,41	124,5 (74-221)
Diastolic BP (mmHg)		71±14,65	71 (37-108)
Pulse rate (bpm)		93,18±17,27	94,5 (62-133)
Oxigen saturation		94,61±3,81	95,5 (82-100)
Height (cm)		170,75±7,87	170,5 (145-187)
Weight (kg)		81±13,34	80 (55-120)
BMI		27,69±3,55	27,32 (19,72-38,97)

GCS: Glasgow Coma Score, BP: Blood Pressure, BMI: Body Mass Index, cm: Centimeter, kg: Kilogram

Table 2. Test performance characteristics for confirming nasogastric tube placement

Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	+LR (95% CI)	-LR (95% CI)	Accuracy (95% CI)
96.3%	100.0%	100.0%	40.0%	N/A	0.04	96.4%
(89.7-99.2)	(15.8-100.0)	(95.4-100)	(18.0-66.9)		(0.01-0.11)	(89.9-99.3)

Table 3. Concordance of nurses' ultrasonography findings and radiography results

		Radiography				Total		Kappa Value	p
		Positive		Negative					
		n	%	n	%	n	%		
Ultrasound	Positive	79	96,3	-	-	79	94	0,556	0
	Negative	3	3,7	2	100	5	6		

predictive power of the nurses' US findings compared to radiography results was found to be 0.982 and statistically significant (p<0.0001) (Table 2) (Figure 1).

Discussion

In this study, we compared nurse-performed US with radiography to confirm the location of NGT in patients in ICU. Our results show that nurses can confirm NGT placement using US with high precision after a short training. This study was carried out with 6 nurses with no experience in US. Hence, we concluded that sonographic confirmation of NGT placement should be explored as a valuable skill for non-physicians in the intensive care setting.

Currently, none of the NGT placement verification methods have been proven to be 100% reliable. Although radiography is recommended as the gold standard confirmation method, it is impractical, for confirmation of NGT [18]. Additionally, repeated radiation exposures, long waiting hours, feeding delays, additional costs and misinterpretations are limitations of radiography [8,19]. Since radiography is impractical and has many limitations, it is important to explore new and practical methods for confirming NGT placement [18,20].

US is one of the promising additional verification methods. In recent years, many studies have reported that US provides good diagnostic accuracy and helps confirm NGT location [8,9,14]. Zatelli et al. investigated the diagnostic accuracy of 4-point ultrasonography to confirm NGT location in 114 intubated patients hospitalized in the ICU and reported that US showed 100% sensitivity. However, this study was carried out by an intensive care specialist who was trained by a radiologist [21]. A multicenter, prospective study by Chenaitia et al showed that US had 98.3% sensitivity and 100% specificity in confirming NGT placement in 130 patients intubated in a prehospital setting. In conclusion, they reported that US is an effective and reliable diagnostic method to confirm NGT location in prehospital settings [22]. Atalay et al. found that radiography and sonography showed 100% sensitivity in confirming NGT placement in a prospective study in the pediatric ICU. They also reported that US, performed by a radiologist, is an effective and sensitive diagnostic procedure for confirming NGT location [23]. According to the meta-analysis by Lin et al, the sensitivity of US was 93% and the specificity was 97%, and they reported that US provided a good diagnostic performance in predicting correct NGT placement [8]. In their prospective study, Yıldırım et al. confirmed the position of the nasogastric tube by giving air-water mixture and auscultation with neck ultrasound and subxiphoid ultrasound in patients with indications for NGT placement in the ED. They found the sensitivity of subxiphoid US to be 78.72% and the specificity to be 100%. After the air-water mixture was given from NGT, the sensitivity reached 91.49% and the specificity reached 100%. In addition, positive and negative predictive values were found to be 100% and 33.33%, respectively [24]. Mak and Tam investigated the efficacy of US to confirm NGT placement and the feasibility of using it as a primary level of reference. This method was found to have a sensitivity of 95.45% and a specificity of 100%, and they showed that US performed by nurses can provide good diagnostic imaging to confirm NGT location [25]. Kim et al. conducted a study comparing the effectiveness of auscultation, pH measurement of gastric aspirates, and sonography to confirm NGT placement in unconscious patients in the ED. They found a sensitivity of 86.4%, a specificity of 66.7%, a positive predictive value of 97.4%, and a negative predictive value of 25% in confirming the NGT placement of US. They concluded that confirmation of NGT location with US can reduce complications and unnecessary radiation exposure [9]. In our study, we showed that following a short training, nurses' confirmation of the NGT location using US had a sensitivity of 96.3% and 100% specificity, 100% positive predictive value and 40% negative predictive value. The results of the US test in this study reflect the findings of other studies in which US has improved the diagnostic accuracy. Accordingly, it has been shown that nurses can also be used to confirm NGT placement in emergency and intensive care conditions.

According to the findings of this study, the high positive predictive value of using US can reduce the number of radiographs and the US image of dynamic fogging after air delivery from the tube may reduce misplacement and complications from misplacement. In this study, US examination appears to be a simple and rapid method for recognizing the correct positioning of the NGT in critically ill patients. This method is faster than traditional x-ray and can be used after a short training period. US is used when radiography is unavailable. Confirmation of NGT location by ultrasonography has the potential to reduce complications, save time, and reduce unnecessary radiation exposure. However, confirmation by chest X-ray is required when ultrasound cannot confirm the localization of the NGT by direct imaging or after a blow of water and air.

A few studies have reported that the failure of US to confirm correct NGT placement is due to gas interposition, and when NGT cannot be visualized in the stomach due to gas interposition, the diagnostic accuracy of dynamic fogging seen in the stomach for correct NGT placement [9,22]. Also, visualization of NGT at the neck is not sufficient to confirm the position of the tube because the tube may bend within the cervical esophagus and may not progress distally. For this purpose, US findings of dynamic fogging were evaluated in order to make US easier and faster for nurses to confirm NGT placement.

Limitations

One of the limitations of this study was the small sample size. Secondly, US confirmed the correct placement of the NGT, but the reduced need for radiography and the delay between the placement of the NGT and initiation of feeding were not investigated. Finally, prospective randomized studies are required to show how sonographic applications would reduce the need for radiography and the complication rates associated with NGT placement.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with

the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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